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Maine Agricultural Experiment Station

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DIGESTION EXPERIMENTS WITH SHEEP AND STEERS.

This bulletin contains the report of digestion experiments made in the years 1901-4 at this Station with sheep and steers. In many instances the same kinds of food were used with both classes of animals, and the coefficients thus obtained are compared. The income and outgo of nitrogen is also reported.

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DIGESTION EXPERIMENTS WITH SHEEP AND STEERS.

J. M. Bartlett.

The experiments here presented were undertaken for the purpose of comparing the digestive capacity of steers with that of sheep. They were begun in the winter of 1901 and completed in 1904, and though the work was carried over a period of nearly four years, not a great many experiments were performed for the reason that only about four months of each year could be devoted to the work, and each experiment required three weeks time.

By far the larger proportion of digestion coefficients obtained in this country are those derived from experiments with sheep, and in calculating rations it has been assumed that these were correct, for all ruminants at least. The small size of sheep and the ease with which they can be handled, probably accounts for their more general use, but our experience with them leads us to believe that, as a rule, they are much less desirable for this purpose than steers. They are nervous, restless and more liable to lose their appetite when confined in stalls, and parallel experiments with two or more animals are subject to wider variations. Out of a dozen different sheep the writed has used, only one really satisfactory animal, equal to the steer, has been found.

DESCRIPTION OF ANIMALS.

The steers used were grade Durhams which were bought in the country and had been rather poorly fed before they came to the Station. They were, therefore, small of their age, weighing about 300 lbs. at one and one-half years old, when the experiments were begun. Although small, they were hearty and rugged, ate their rations well and did not appear to mind the confinement.

The sheep employed for the first two seasons were young Shropshires that were not very satisfactory. They were small eaters, especially of coarse fodders, and had to be handled very carefully to prevent them from getting out of condition. The third season large well matured lambs were obtained, but they did not take kindly to the confinement, probably because they were so young, and all comparative experiments with them had to be abandoned. The fourth season they were again tried and were more satisfactory.

METHOD.

The method of experiment employed with the sheep was practically the same as has been previously used at this Station, and described in Report for 1891, p. 25, except that the platform on which the sheep stood was raised so that the urine could be collected. For this purpose a rubber funnel was attached with straps passing over the animal's back, and a rubber tube led from it to convey the urine to a vessel beneath the platform. The whole experiment covered a period of twelve or thirteen days, the first seven days being a preliminary feeding period, while during the last five or six days the feces and urine were all collected, weighed and sampled for analysis.

The first two seasons the steers were so small that rubber lined pouches for collecting the feces, similar to those used on sheep, worked very satisfactorily. But during the third summer they made very rapid growth and attained such size that the pouch was no longer practicable and a galvanized iron trough was set in the rear of the platform so that it would secure all the droppings, and a strong wire running across behind the steer prevented him from stepping back into it. The stall and platform were just long enough to accommodate the animal, and all feces fell into the galvanized iron trough. Each ration of hay and grain were carefully weighed, the feces were collected in iron tubs and weighed at the end of the period on the same scales used to weigh the ration. The work was only carried on during cold weather, so no fermentation took place. The urine from the steers was collected with rubber funnels the same as with sheep. Between the experiments the animals were given a week's rest, which was necessary to keep them in good condition.

EXPLANATION OF TABLES.

The tables given on pages 188-189 contain the figures representing the chemical composition, or percentages of nutrients in the foods used in each experiment; also the composition of the feces for each sheep, and the heat of combustion for the foods and feces. The percentages given are on the same moisture bases as the figures given in the tables which follow. The tables on pages 190-191 contain the same data as the above relating to the steers.

The table on page 192 gives the total amount of food consumed by each sheep for each experiment and the feces excreted, also the time covered by the experiments.

The table on page 193 contains the percentage of each nutrient digested or the digestive coefficients for each sheep.

The table on page 194 gives the amount of food consumed by each steer and the feces excreted for each experiment.

The table on page 195 gives the digestion coefficients obtained for each steer.

In the tables on pages 196-197 are given a summary of the coefficients obtained in the experiments described in this bulletin. In the Station reports for 1897 and 1900 will be found summary tables giving all digestion coefficients which have been obtained at this Station previously.

The tables given on page 198 contain the average coefficients obtained for both sheep and steers on the different feed stuffs and mixtures, used in the experiments made to compare their digestive capacities.

The table on page 199 contains the coefficients obtained with the steers alone on mixtures of hay, corn meal and gluten meal.

The description of each experiment follows the tables on pages 199 and following:

COMPOSITION OF FOODS AND FECES IN DIGESTION EXPERIMENTS WITH SHEEP.

	Station number.	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Calories per gram.
Experiment 86.		%	%	%	%	%	%	%	Cal.
Clover silage	4259	21.14	19.20	1.94	2.25	8.25	7.97	0.73	1.073
Feces, Sheep I	4260	91.24	81.57	9.67	10.56	33.76	33.95	3.30	4.223
Feces, Sheep II	4261	91.25	81.76	9.49	11.94	33.09	33.51	3.22	4.201
Feces, Sheep III	4262	90.83	81.30	9.53	10.13	31.82	36.46	2.89	4.205
Experiment 87.									
Clover hay	4263	81.46	75.63	5.83	7.90	27.63	38.34	1.76	3.635
Feces, Sheep I	4264	91.45	83.14	8.31	8.56	35.44	36.79	2.35	4.294
Feces, Sheep II	4265	91.86	82.78	9.08	8.56	35.06	36.69	2.47	4.177
Feces, Sheep III	4266	91.79	83.79	8.00	8.75	34.76	37.92	2.36	4.179
Experiment 88.									
Timothy hay	4274	80.06	75.67	4.39	4.93	24.57	44.02	2.15	3.618
Feces, Sheep I	4275	91.90	85.16	6.74	7.63	30.01	43.75	3.77	4.379
Feces, Sheep III	4277	91.64	85.08	6.56	6.94	30.59	44.33	3.22	4.343
Experiment 89.									
Hay	4274	80.06	75.67	4.39	4.93	24.57	44.02	2.15	3.618
Coarse spring wheat bran	4309	92.57	86.01	6.56	16.63	11.17	53.11	5.00	4.118
Feces, Sheep I	4268	92.02	83.20	8.82	8.69	25.83	43.52	5.16	4.374
Feces, Sheep II	4269	90.83	81.75	9.08	8.94	24.49	43.60	4.72	4.227
Feces, Sheep III	4270	91.61	83.39	8.22	8.31	25.73	44.18	5.17	4.356
Experiment 90.									
Hay	4274	80.06	75.67	4.39	4.93	24.57	44.02	2.15	3.614
Winter wheat mixed feed	4310	90.70	84.60	6.10	16.13	13.33	49.94	5.20	4.044
Feces, Sheep II	4272	91.77	83.24	8.53	9.13	26.80	43.71	3.60	4.333
Feces, Sheep III	4273	92.16	83.78	8.50	8.50	26.85	45.44	2.99	4.223
Experiment 91.									
Hay	4278	82.58	78.60	3.98	4.87	25.78	45.59	2.36	3.691
Cottonseed meal	4211	91.99	84.40	7.59	46.75	6.23	21.64	9.78	4.662
Feces, Sheep II	4288	91.02	83.26	7.76	9.31	28.69	41.93	3.33	4.262
Feces, Sheep III	4289	91.02	84.01	7.01	9.06	27.99	43.68	3.28	4.310
Experiment 92.									
Hay	4278	82.58	78.60	3.98	4.87	25.78	45.59	2.36	3.691
Cottonseed meal	4311	91.99	84.40	7.59	46.75	6.23	21.64	9.78	4.662
Feces, Sheep II	4291	90.45	81.91	8.54	10.50	28.53	39.89	2.99	4.200
Feces, Sheep III	4292	90.58	82.11	8.74	10.81	27.67	40.60	3.09	4.236
Experiment 93.									
Hay	4306	83.90	79.66	4.24	5.00	26.98	44.26	3.42	3.810
Coarse corn meal	4307	87.54	86.62	1.02	9.06	2.25	72.25	2.96	3.881
Feces, Sheep II	4293	89.69	83.17	6.52	9.75	27.92	41.91	3.59	4.279
Feces, Sheep III	4295	90.52	84.49	6.03	8.81	30.26	42.44	2.98	4.268
Experiment 94.									
Hay	4306	83.90	79.66	4.24	5.00	26.98	44.26	3.42	3.810
Fine corn meal	4308	87.53	86.51	1.02	8.81	2.09	72.28	3.33	3.903
Feces, sheep II	4297	89.32	83.17	6.15	8.56	28.29	43.25	3.07	4.236
Experiment 102.									
Corn fodder	4313	51.38	48.06	3.32	4.24	15.61	27.28	0.93	2.260
Waste, Sheep I	4324	46.13	40.43	5.70	3.99	13.22	22.45	0.77	
Waste, Sheep II	4325	43.71	40.93	2.78	3.14	14.25	23.04	0.50	
Feces, Sheep I	4327	88.63	75.90	12.73	11.13	20.75	42.07	1.95	3.964
Feces, Sheep II	4328	89.74	77.83	11.91	10.75	23.77	41.76	1.55	4.004
Experiment 103.									
Leaming corn silage	4315	19.60	18.60	1.00	1.60	5.42	11.09	.49	.916
Feces, Sheep I	4329	89.58	81.70	7.88	9.44	25.09	45.81	1.36	4.076
Feces, Sheep II	4330	89.43	81.81	7.62	8.81	27.57	44.01	1.42	4.053

COMPOSITION OF FOODS AND FECES, SHEEP—CONCLUDED.

	Station number.	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Calories per gram.
Experiment 104.		%	%	%	%	%	%	%	Cal.
Timothy hay	4319	84.65	80.08	4.57	5.32	27.62	44.99	2.15	3.791
Feces, Sheep I	4333	90.00	83.23	6.77	7.75	31.41	41.72	2.35	4.262
Feces, Sheep II	4334	89.44	82.08	7.36	7.63	29.79	42.13	2.53	4.231
Experiment 105.									
Hay	4319	84.65	80.08	4.57	5.32	27.62	44.99	2.15	3.791
Linseed meal	4359	89.44	83.71	5.73	40.81	7.86	33.53	1.51	4.097
Feces, Sheep II	4336	89.81	81.22	8.59	11.63	29.44	37.52	2.63	4.193
Experiment 106.									
Hay	4320	82.24	94.71	5.29	6.77	33.10	52.51	2.33	
Corn meal	4360	81.16	98.39	1.61	13.01	2.56	79.97	2.85	
Feces, Sheep I	4337	89.50	80.28	9.22	12.44	27.14	38.39	2.31	
Experiment 118.									
Soy-bean—corn silage	4408	20.20	19.03	1.17	2.13	5.11	9.62	2.17	8.722
Feces, Sheep I	4392	91.92	81.88	10.04	10.69	29.72	37.98	3.49	4.168
Feces, Sheep II	4393	91.55	79.79	11.76	14.25	26.65	35.74	3.15	4.107
Experiment 119.									
Hay	4405	81.54	77.08	4.46	6.60	24.50	43.20	2.82	3.712
Feces, Sheep I	4388	91.09	83.19	7.90	8.44	28.60	42.12	2.68	4.201
Feces, Sheep II	4389	90.93	82.40	8.53	10.00	29.70	38.45	2.65	4.177
Experiment 120.									
Hay	4410	82.49	77.96	4.53	7.47	25.76	42.08	2.65	3.790
Linseed meal	4419	91.71	86.49	5.22	31.13	9.43	32.36	8.59	4.523
Corn meal	4418	88.55	87.27	1.28	8.44	1.99	72.95	2.54	3.891
Feces, Sheep I	4390	92.37	22.94	9.43	11.69	27.85	38.36	3.17	4.261
Feces, Sheep II	4391	92.94	83.79	9.15	11.75	27.30	39.45	3.41	4.285
Experiment 121.									
Hay	4411	85.36	81.23	4.13	7.04	25.19	46.20	2.80	4.000
Middlings	4420	90.92	86.93	3.99	18.13	5.22	55.97	4.71	4.165
Feces, Sheep I	4394	91.06	82.20	8.86	9.31	28.43	40.32	2.65	4.139
Feces, Sheep II	4395	91.86	82.56	9.30	9.31	29.15	39.82	2.79	4.222
Experiment 122.									
Hay	4414	86.05	81.68	4.37	6.49	26.63	45.98	2.58	3.945
Low grade cottonseed meal	4425	90.48	85.78	4.70	23.81	21.43	30.53	6.20	4.389
Feces, Sheep I	4396	90.82	82.89	7.93	11.00	31.73	36.40	2.00	4.185
Feces, Sheep II	4397	92.02	84.41	7.61	11.38	31.60	37.54	2.07	
Experiment 123.									
Hay	4416	89.20	84.53	4.67	7.37	27.53	46.41	3.22	4.013
Medium grade cottonseed meal	4424	88.40	81.90	6.50	34.13	13.58	19.83	8.90	3.854
Feces, Sheep I	4400	91.54	81.66	9.88	12.44	29.73	34.96	2.54	4.172
Feces, Sheep II	4401	91.94	81.60	10.34	11.88	31.20	34.59	2.03	4.150
Experiment 124.									
Hay	4415	87.34	83.09	4.25	6.66	27.36	46.31	2.76	4.007
Cottonseed meal(dark col'r'd)	4423	87.28	80.23	7.05	42.50	7.67	14.64	8.62	3.785
Feces, Sheep I	4398	91.21	80.85	10.36	14.00	27.03	35.14	2.44	4.184
Feces, Sheep II	4399	90.79	80.49	10.30	15.00	27.77	33.06	2.26	4.152

COMPOSITION OF FOODS AND FECES IN DIGESTION EXPERIMENTS WITH STEERS.

	Station number.	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Calories per pound.
		%	%	%	%	%	%	%	
Experiment 95.									
Hay	4274	80.06	75.67	4.39	4.93	24.57	44.02	2.15	1,641
Feces, Steer I	4279	91.11	84.60	6.51	8.38	28.54	44.35	3.33	1,993
Feces, Steer II	4280	92.14	85.56	6.58	7.81	28.04	46.25	3.46	1,993
Experiment 96.									
Hay, 4,274.									
Spring wheat bran	4309	92.57	86.01	6.56	16.63	11.17	53.21	5.00	1,868
Feces, Steer I	4283	90.94	81.25	8.69	9.19	26.78	43.13	3.15	1,930
Feces, Steer II	4284	90.72	81.76	8.96	9.44	27.06	41.63	3.63	1,934
Experiment 97.									
Hay, 4,274.									
Winter wheat mixed feed	4310	90.70	84.60	6.10	16.13	13.33	49.94	5.20	1,834
Feces, Steer I	4281	91.61	83.34	8.27	9.06	26.45	44.86	2.97	1,913
Feces, Steer II	4282	91.06	82.72	8.24	9.25	27.22	42.89	3.46	1,923
Experiment 98.									
Hay	4304	88.26	84.01	4.25	5.42	28.45	46.83	3.31	1,788
Cottonseed meal	4311	91.99	84.40	7.59	46.75	6.23	21.64	9.78	2,115
Feces, Steer I	4285	91.43	83.66	7.77	10.69	28.47	41.57	2.93	1,947
Feces, Steer II	4286	90.49	82.39	8.10	10.38	27.98	40.95	3.08	1,947
Experiment 99.									
Hay	4278	82.58	78.60	3.98	4.87	25.78	45.59	2.36	1,674
Cottonseed meal	4311	91.99	84.40	7.59	46.75	6.23	21.64	9.78	2,115
Feces, Steer I	4298	91.28	83.11	8.17	11.25	27.49	41.29	3.08	1,942
Feces, Steer II	4299	90.53	82.51	8.02	11.31	27.05	40.87	3.28	1,934
Experiment 100.									
Hay	4306	83.90	79.66	4.24	5.00	26.08	44.26	3.42	1,728
Coarse corn meal	4307	87.54	86.52	1.02	9.06	2.25	72.25	2.96	1,760
Feces, Steer I	4300	90.24	83.82	6.42	9.19	29.23	42.16	3.24	1,952
Feces, Steer II	4301	91.54	84.66	6.88	9.44	27.17	44.57	3.48	1,970
Experiment 101.									
Hay, 4,306.									
Fine corn meal	4308	87.53	86.51	1.02	8.81	2.09	72.28	3.33	1,770
Feces, Steer I	4302	89.71	83.48	6.23	9.38	28.85	42.05	3.20	1,940
Feces, Steer II	4303	91.50	85.02	6.48	9.44	28.03	44.62	2.93	1,977
Experiment 107.									
Corn fodder	4313	51.38	48.06	3.32	4.24	15.61	27.28	.93	1,025
Feces, Steer I	4341	89.23	77.80	11.43	11.75	20.01	44.44	1.60	1,847
Feces, Steer II	4342	89.29	78.92	10.37	11.63	20.41	45.15	1.73	1,859
Experiment 108.									
Sanford corn silage	4314	20.19	19.14	1.05	1.41	5.27	12.01	0.45	415
Feces, Steer I	4343	89.27	79.60	9.67	11.13	20.99	45.58	1.90	1,863
Feces, Steer II	4344	89.20	79.11	10.09	11.88	21.06	44.25	1.92	1,851
Experiment 109.									
Leaming corn silage	4315	19.60	18.60	1.00	1.60	5.42	11.09	0.49	415
Feces, Steer I	4345	89.96	82.18	7.78	9.69	23.10	47.91	1.48	1,877
Feces, Steer II	4346	89.33	79.89	9.44	11.13	20.07	47.11	1.58	1,850
Experiment 110.									
Feed flour	4358	82.14	79.18	2.96	21.38	2.25	54.83	0.72	1,702
Feces, Steer I	4347	89.94	79.59	10.35	12.81	21.49	43.12	2.17	1,873
Feces, Steer II	4348	89.54	79.10	10.44	12.38	22.26	42.56	1.90	1,845
Experiment 111.									
Hay, mostly timothy	4319	84.65	80.08	4.57	5.32	27.62	44.99	2.15	1,719
Feces, Steer I	4351	89.95	82.71	7.24	9.06	28.37	42.30	2.98	1,956
Feces, Steer II	4352	89.08	81.89	7.19	8.56	28.24	42.23	2.86	1,944

COMPOSITION OF FODDERS AND FECES, STEERS—CONCLUDED.

	Station number.	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Calories per pound, air dry or fresh.
Experiment 112.		%	%	%	%	%	%	%	
Linseed meal	4359	89.44	83.71	5.73	40.81	7.86	33.53	1.51	1,958
Feces, Steer I	4353	89.70	81.31	8.39	10.81	27.37	40.45	2.68	1,906
Experiment 113.									
Hay	4321	87.11	82.49	4.62	5.24	29.63	45.77	1.85	
Linseed meal	4359								
Corn meal	4360	81.16	79.85	1.31	10.56	2.08	64.90	2.30	
Feces, Steer II	4355	90.26	82.17	8.09	11.13	27.92	40.44	2.68	
Experiment 114.									
Hay	4362	84.46	79.53	4.93	5.94	27.25	44.02	2.32	1,709
Feces, Steer I	4363	19.04	17.33	1.71	1.66	6.87	8.11	.69	402
Feces, Steer II	4364	20.36	18.47	1.89	1.85	7.11	8.77	.74	433
Experiment 115.									
Hay	4365	83.00	77.59	5.41	6.28	26.15	42.81	2.35	1,692
Corn meal	4375	88.94	78.63	1.31	9.74	1.58	72.51	3.80	1,775
Feces, Steer I	4366	18.25	16.63	1.62	2.52	5.23	8.09	.79	393
Feces, Steer II	4367	18.39	16.61	1.78	2.51	5.33	7.99	.78	400
Experiment 116.									
Hay	4368	85.28	79.42	5.86	7.17	28.78	41.31	2.16	1,747
Gluten feed	4376	90.61	89.57	1.04	26.38	8.48	50.72	3.99	399
Feces, Steer I	4369	17.81	16.13	1.68	2.56	4.72	8.14	0.71	402
Feces, Steer II	4370	18.41	16.58	1.83	2.68	4.80	8.34	0.76	399
Experiment 117.									
Hay	4368	85.10	79.52	5.58	7.72	26.40	42.83	2.57	1,747
Gluten feed	4376								
Feces, Steer I	4372	16.48	14.85	1.63	2.24	4.94	7.13	0.54	403
Feces, Steer II	4373	18.75	16.62	2.13	2.51	5.53	7.98	0.60	399
Experiment 125.									
Soy-bean—corn silage	4406	18.92	17.87	1.05	1.90	5.06	......	......	370
Feces, Steer II	4382	14.55	1.82	1.82	2.13	4.95	5.14	.51	302
Experiment 126.									
Hay	4404	82.74	78.37	4.37	7.45	25.17	42.83	2.92	1,661
Soy-bean—corn silage	4407	20.94	19.61	1.33	1.98	5.42	11.55	0.66	408
Feces, Steer I	4383	17.53	16.70	1.83	2.08	5.92	7.27	.43	348
Feces, Steer II	4384	15.88	14.30	1.58	1.84	5.45	6.63	.38	324
Experiment 127.									
Hay	4404	82.74	78.37	4.37	7.45	25.17	42.83	2.92	1,661
Feces, Steer I	4377	20.35	18.56	1.79	2.14	6.04	9.38	1.01	438
Feces, Steer II	4378	22.33	20.33	2.00	2.47	6.58	10.19	1.09	479
Experiment 128.									
Hay	4409	91.29	86.59	4.70	7.81	27.62	46.62	3.29	1,661
Corn meal	4418	88.55	87.27	1.28	8.44	1.99	72.95	2.54	1,765
Linseed meal	4419	91.71	86.49	5.22	31.13	9.43	32.36	8.59	2,051
Feces, Steer I	4379	20.14	18.18	1.96	2.62	5.94	8.98	0.74	428
Feces, Steer II	4380	21.33	19.35	1.98	2.50	6.51	9.59	0.75	454
Experiment 129.									
Hay	4412	87.50	83.07	4.43	6.34	26.65	47.13	2.95	1,817
Spring wheat middlings	4421	86.52	83.50	3.02	13.31	4.18	60.96	2.92	1,680
Feces, Steer II	4387	21.06	18.45	2.61	2.56	6.40	8.84	0.65	459

DATA RELATIVE TO DIGESTION EXPERIMENTS WITH SHEEP.

Number of experiment.	Animal's number.	Length of experiment in days.	The food consumed by each animal during the experiment.	Total feces—grams.
86	I..	5	Clover silage, 15,000 grams	1,970
86	II..	5	Clover silage, 10,000 grams	1,463
86	III..	5	Clover silage, 12,500 grams	1,875
87	I..	5	Clover hay, 5,000 grams	2,133
87	II..	5	Clover hay, 4,000 grams	1,731
87	III..	5	Clover hay, 4,000 grams	1,775
88	I..	5	Timothy hay, 4,859 grams	2,165
88	III..	5	Timothy hay, 3,936 grams	1,825
89	I..	5	Hay, 3,000 grams, coarse spring bran, 1,500 grams	1,813
89	II..	5	Hay, 3,000 grams, coarse spring bran, 1,500 grams	1,828
	III..	5	Hay, 3,000 grams, coarse spring bran, 1,500 grams	1,833
90	II..	5	Hay, 3,000 grams, winter wheat mixed feed, 1,500 gr.	1,678
90	III..	5	Hay, 3,000 grams, winter wheat mixed feed, 1,500 gr.	1,768
91	II..	5	Hay, 4,000 grams, cottonseed meal, 500 grams	1,866
91	III..	5	Hay, 4,000 grams, cottonseed meal, 500 grams	1,909
92	II..	5	Hay, 4,000 grams, cottonseed meal, 1,000 grams	1,971
92	III..	5	Hay, 4,000 grams, cottonsesd meal, 1,000 grams	1,946
93	I..	5	Hay, 3,000 grams, coarse corn meal, 1,000 grams	1,522
93	III..	5	Hay, 3,000 grams, coarse corn meal, 1,000 grams	1,697
94	II..	5	Hay, 3,000 grams, fine corn meal, 1,000 grams	1,547
102	I..	6	Corn fodder, 4,200 grams, 483 grams waste	754
102	II..	6	Corn fodder, 4,200 grams, 313 grams waste	843
103	I..	6	Leaming corn silage, 15,000 grams	1,243
103	II..	6	Leaming corn silage, 15,000 grams	1,354
104	I..	5	Timothy hay, 3,500 grams	1,346
104	II..	5	Timothy hay, 3,500 grams	1,345
105	III..	5	Hay, 3,500 grams, linseed meal, 1,500 grams	1,406
106	I..	5	Hay, 2,500 grams, linseed meal, 1,000 grams, corn meal, 1,000 grams	1,137
118	I..	6	Soy bean—corn silage, 18,000 grams	1,182
118	II..	6	Soy bean—corn silage, 12,000 grams	727
119	I..	6	Hay, 6,000 grams	2,717
119	II..	6	Hay, 4,800 grams	2,191
120	I..	6	Hay, 3,600 gr., linseed meal, 900 gr., corn meal, 900 gr.	1,905
120	II..	6	Hay, 3,600 gr., linseed meal, 900 gr., corn meal, 900 gr.	1,881
121	I..	6	Hay, 4,800 grams, middlings, 2,400 grams	2,726
121	II..	6	Hay, 2,400 grams, middlings, 1,200 grams	1,392
122	I..	6	Hay, 6,000 grams, low grade cottonseed meal, 3,000 gms.	4,075
122	II..	6	Hay, 3,600 grams, low grade cottonseed meal, 1,800 gms.	2,311
123	I..	6	Hay, 6,000 gr., medium grade cottonseed meal, 3,000 gr.	3,833
123	II..	6	Hay, 4,800 gr., medium grade cottonseed meal, 2,400 gr.	2,843
124	I..	6	Hay, 6,000 grams, cottonseed meal (off color) 3,000 gms.	3,471
124	II..	6	Hay, 6,000 grams, cottonseed meal (off color) 2,400 gms.	2,545

COEFFICIENTS OBTAINED IN DIGESTION EXPERIMENTS WITH SHEEP.

Material.	Number of experiment.	Animal's number.	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Fuel value.
			%	%	%	%	%	%	%	%
Clover silage.	86	I	43.3	44.2	34.5	38.3	46.3	44.1	40.6	47.7
	86	II	36.8	37.7	28.5	22.4	41.3	38.5	35.5	40.8
	86	III	31.7	36.4	26.3	32.3	42.1	31.2	40.4	39.7
Clover hay.	87	I	52.1	53.1	39.2	53.8	42.4	59.1	43.4	51.0
	87	II	48.8	52.6	32.6	53.1	45.2	58.6	40.7	49.3
	87	III	50.2	51.0	39.3	51.0	44.4	56.3	41.0	48.1
Timothy hay.	88	I	49.1	50.1	31.0	31.5	45.7	58.0	23.3	47.2
	88	II	47.1	48.0	30.3	35.0	43.9	53.5	31.3	44.2
Coarse spring wheat bran..	89	I	69.6	66.6	30.4	76.4	63.1	74.2	37.7	
	89	II	70.1	73.7	24.2	74.1	75.6	73.2	47.6	
	89	III	69.5	72.8	31.5	76.3	66.7	73.0	40.5	64.0
Winter wheat bran (mixed feed).	90	II	78.4	80.9	43.4	77.4	78.5			
	90	III	71.9	74.6	35.5	78.6	66.0	......	......	71.8
Hay and cottonseed meal 8 to 1.	91	II	54.8	56.4	26.5	59.4	49.6	59.4	56.2	52.3
	91	III	53.8	55.6	32.0	59.6	49.7	56.8	55.9	50.6
Hay and cottonseed meal 8 to 2.	92	II	57.7	59.2	28.3	68.7	48.5	61.4	69.2	55.4
	92	III	58.2	59.9	29.8	68.2	50.7	61.2	69.2	50.9
Coarse corn meal.	93	I	93.2	94.0	......	46.5	......	79.1	......	78.3
	93	III	73.7	74.9	......	45.4	......	81.5		
Fine corn meal.	94	II	89.2	90.2	31.3	63.2	56.4	88.6	......	88.0
Cut corn fodder.	102	I	65.5	68.7	14.2	47.2	72.6	69.4	52.6	
	102	II	62.5	65.3	23.0	46.2	67.2	67.0	66.0	
Leaming corn silage.	103	I	61.2	63.5	34.7	51.2	61.6	65.8	77.0	46.4
	103	II	58.8	60.3	31.8	50.5	54.0	64.2	73.9	42.7
Timothy hay, some clover.	104	I	59.1	60.0	43.0	43.9	56.2	64.3	57.9	56.2
	104	II	59.7	65.7	38.5	45.2	58.8	63.6	55.0	56.5
Linseed meal.	105	II	95.5	88.6	69.6	90.1	......	......	81.4	88.4
Linseed meal and corn meal (mixed equal parts).	106	I	89.2	91.2	42.6	87.5	80.4	95.1	85.9	
	106	II	82.4	93.9	......	78.3	......	......	89.0	......
Soy bean—corn silage.	118	I	70.1	71.8	45.6	67.0	61.8	74.1	89.4	67.2
	118	II	72.6	74.6	39.1	68.2	68.4	79.4	91.2	71.2
Hay, largely timothy.	119	I	49.4	51.1	19.7	42.1	47.2	55.9	57.0	48.1
	119	II	49.3	51.2	16.2	36.5	45.9	57.7	57.1	48.5
Linseed and corn meal (equal parts).	120	I	83.3	86.4	......	85.4	71.2	90.5	80.5	81.0
	120	II	84.1	86.7	......	85.9	88.4	89.4	76.8	81.7
Spring wheat middlings.	121	I	81.5	83.8	......	91.0	......	87.8	87.0	82.3
	121	II	78.1	81.1	......	90.6	......	87.5	84.5	76.8
Low grade cottonseed meal	122	I	60.1	61.5	......	71.9	30.3	65.7	87.3	58.7
	122	II	62.8	66.6	......	73.3	45.2	69.5	92.8	
Medium grade cottonseed meal.	123	I	66.8	73.3	......	80.9	39.8	72.8	94.6	61.6
	123	II	79.2	82.7	......	86.2	47.2	91.3	......	71.8
Dark cottonseed meal.	124	I	80.6	84.5	......	81.8	......	89.7	94.7	72.1
	124	II	91.0	95.2	......	82.5	......	99.6	99.7	83.4

DATA RELATIVE TO DIGESTION EXPERIMENTS WITH STEERS.

Number of experiment.	Animal's number.	Length of experiment in days.	The food consumed by each animal during each experiment.	Total feces air dry or fresh—pounds.
95	I	5	Timothy hay, 40 pounds	15.8
95	II	5	Timothy hay, 40 pounds	15.7
96	I	5	Hay, 35 pounds, coarse spring wheat bran, 15 pounds.	19.4
96	II	5	Hay, 35 pounds, coarse spring wheat bran, 15 pounds.	18.7
97	I	5	Hay, 35 pounds, winter wheat bran, 15 pounds	18.2
97	II	5	Hay, 35 pounds, winter wheat bran, 15 pounds	18.2
98	I	5	Hay, 40 pounds, cottonseed meal, 5 pounds	18.5
98	II	5	Hay, 40 pounds, cottonseed meal, 5 pounds	18.7
99	I	5	Hay, 40 pounds, cottonseed meal, 10 pounds	18.7
99	II	5	Hay, 40 pounds, cottonseed meal, 10 pounds	18.8
100	I	5	Hay, 50 pounds, coarse corn meal, 10 pounds	23.0
100	II	5	Hay, 40 pounds, coarse corn meal, 10 pounds	21.7
101	I	5	Hay, 50 pounds, fine corn meal, 10 pounds	22.1
101	II	5	Hay, 40 pounds, fine corn meal, 10 pounds	18.0
107	I	5	Corn fodder, 70 pounds	10.8
107	II	5	Corn fodder, 70 pounds	11.1
108	I	5	Sanford corn silage, 200 pounds	11.7
108	II	5	Sanford corn silage, 200 pounds	11.1
109	I	5	Leaming corn silage, 150 pounds	13.0
109	II	5	Leaming corn silage, 150 pounds	11.7
110	I	5	Leaming corn silage, 150 pounds, feed flour, 20 lbs	14.8
110	II	5	Leaming corn silage, 150 pounds, feed flour, 20 lbs	14.2
111	I	5	Hay, 50 pounds	19.6
111	II	5	Hay, 50 pounds	19.8
112	I	5	Hay, 50 pounds, linseed meal, 10 pounds	21.3
113	II	5	Hay, 50 lbs., linseed meal, 10 lbs., corn meal, 10 lbs	21.7
114	I	5	Hay, 80 pounds	148.0
114	II	5	Hay, 80 pounds	135.3
115	I	5	Hay, 50 pounds, 30 pounds corn meal	115.8
115	II	5	Hay. 50 pounds, 30 pounds corn meal	116.0
116	I	5	Hay, 50 pounds, 30 pounds gluten feed	116.5
116	II	5	Hay, 50 pounds, 30 pounds gluten feed	108.0
117	I	5	Hay, 50 pounds, 15 pounds gluten feed	113.5
117	II	5	Hay, 50 pounds, 15 pounds gluten feed	100.5
125	II	6	Soy bean—corn silage, 325 pounds	127.0
126	I	6	Hay, 30 pounds, soy bean—corn silage, 240 pounds	144.0
	II	6	Hay, 60 pounds, soy bean—corn silage, 240 pounds	237.0
127	I	6	Hay, 108 pounds	180.5
	II	6	Hay, 108 pounds	190.3
128	I	6	Hay, 72 lbs., corn meal, 18 lbs., linseed meal, 18 lbs	155.5
	II	6	Hay, 72 lbs., corn meal, 18 lbs., linseed meal, 18 lbs	160.5
129	II	6	Hay, 72 pounds, middlings, 36 pounds	157.5

COEFFICIENTS OBTAINED IN DIGESTION EXPERIMENTS WITH STEERS.

Material Fed.	Number of experiment.	Animal's number.	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Fuel value.
			%	%	%	%	%	%	%	%
Hay, largely Timothy.	95	I	55.1	55.9	41.5	33.0	54.3	60.2	36.3	51.6
	95	II	54.78	55.5	41.5	37.6	55.3	58.6	35.2	51.7
Spring wheat bran (coarse)	96	I	64.2	68.9	20.4	73.5	21.8	73.5	82.7	
	96	II	68.67	72.4	20.4	73.9	29.9	80.1	73.4	63.6
Winter wheat bran (mixed feed).	97	I	70.4	73.0	33.7	76.5	53.5	74.4	92.3	
	97	II	71.1	73.0	34.8	76.9	47.0	78.5	80.8	70.0
Hay and cottonseed meal 8 to 1.	98	I	57.5	59.1	69.9	56.1	54.9	61.1	70.1	54.9
	98	II	57.5	59.2	72.3	56.9	55.2	61.3	68.5	54.4
Hay and cottonseed meal 8 to 2.	99	I	59.5	61.0	35.3	68.1	52.8	62.0	69.7	56.6
	99	II	59.6	61.0	35.7	67.8	53.4	62.2	67.1	56.6
Coarse corn meal.	100	I	78.4	81.2	......	46.2	......	90.1		
	100	II	88.7	91.9	......	53.9	.....	90.5	......	80.0
Fine corn meal.	101	I	88.4	90.3	......	47.7	......	94.8		
	101	II	86.7	88.5	......	50.6	......	91.3	......	90.0
Cut corn fodder.	107	I	73.2	75.0	47.0	57.2	80.2	74.9	73.8	71.2
	107	II	72.6	74.1	50.4	56.6	79.3	73.9	70.8	70.4
Sanford corn silage.	108	I	74.0	75.5	47.7	53.9	76.6	77.8	76.3	73.2
	108	II	75.7	77.3	47.1	53.5	77.9	79.7	77.7	74.7
Leaming corn silage.	109	I	60.4	61.9	32.7	47.5	63.3	62.2	60.8	60.2
	109	II	65.8	67.7	30.7	45.9	71.1	65.9	75.7	64.5
Feed flour.	110	I	66.8	70.1	......	78.2	......	77.7	......	73.9
	110	II	67.1	70.3	......	80.0	......	73.3		
Hay, Timothy with some clover.	111	I	58.4	59.6	37.9	34.2	59.8	63.2	46.3	55.1
	111	II	58.2	59.8	37.9	36.4	59.4	62.7	47.2	54.9
Linseed meal.	112	I	84.1	87.2	36.8	85.7	69.6	91.4	......	81.3
Linseed meal and corn meal.	113	II	91.5	92.5	52.8	86.2	93.0	96.8	81.3	
Hay, largely Timothy.	114	I	58.3	59.7	35.8	48.2	53.4	65.9	45.2	57.5
	114	II	59.2	60.7	35.0	47.4	55.9	66.3	45.7	56.9
Mixture—Hay 10 lbs. and corn meal 6 lbs.	115	I	69.0	70.4	39.5	51.9	66.2	78.3	60.8	66.1
	115	II	68.7	70.4	33.4	51.9	65.3	78.5	61.2	64.0
Mixture—Hay 10 lbs. and gluten feed 6 lbs.	116	I	70.3	71.8	38.3	74.1	67.5	73.6	63.7	66.5
	116	II	71.5	73.1	38.9	74.8	69.4	74.9	63.9	68.5
Gluten feed—Hay 10 lbs., gluten feed 3 lbs.	117	I	91.3	92.3	......	85.4	......	89.1		
	117	II	90.4	93.4	......	86.0	......	90.0	......	86.3
Soy bean—corn silage.	125	II	70.5	72.2	31.3	56.4	61.7	80.5	66.7	67.7
Soy bean—corn silage, fed with hay.	126	I	69.0	70.5	43.6	53.5	50.8	79.7	......	71.7
	126	II	61.7	71.6	48.0	61.9	59.6	80.4	88.3	68.5
Hay, largely Timothy.	127	I	58.9	60.4	31.6	39.6	59.9	63.4	42.3	55.3
	127	II	52.5	54.3	19.5	41.7	54.0	58.2	34.2	48.6
Corn and linseed meal. (Equal parts.)	128	I	93.43	94.5	54.7	84.8	67.5	95.8	......	81.2
	128	II	84.44	85.6	43.4	85.7	87.4	88.2	......	76.2
Middlings.	129	II	83.4	88.3	......	72.7	......	98.6	......	82.9

SUMMARY OF DIGESTION COEFFICIENTS WITH SHEEP.

Material.	Number of experiment.	Number of animals.	Dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Ether extract.	Fuel value.
Clover silage	86	3	% 37.3	% 39.4	% 29.8	% 31.0	% 43.2	% 37.9	% 38.8	% 42.7
Clover hay	87	3	50.4	52.2	37.0	52.6	43.9	58.0	41.7	49.4
Timothy hay (late cut)	88	2	48.1	49.1	30.7	33.3	44.8	55.8	27.3	46.0
Mixed hay (some clover)	104	2	59.4	60.5	40.8	44.6	57.5	64.0	56.5	58.4
Hay largely timothy	119	2	49.3	51.2	16.2	36.5	45.9	57.7	57.1	48.5
Corn fodder (few ears glazed)	102	2	64.0	67.0	18.6	46.7	69.9	68.2	59.3	
Corn silage (immature corn)	103	2	60.0	61.9	33.3	50.9	57.8	65.0	75.5	44.6
Soy bean—corn silage	118	2	71.4	73.2	42.7	62.6	65.1	76.8	90.3	69.2
Coarse spring wheat bran	89	3	69.5	72.8	31.5	76.3	66.7	73.0	40.5	64.0
Winter wheat, mixed feed	90	2	72.5	77.6	39.5	78.0	72.3	......	......	71.8
Coarse corn meal	93	2	83.5	84.6	......	46.0	......	80.3	......	78.3
Fine corn meal	94	1	89.2	90.2	......	63.2	......	88.6	......	88.0
Cottonseed meal, high grade	92	2	*94.0	*99.1	26.7	82.1	......	93.1	100	......
Cottonseed meal, dark color	122	2	85.8	89.9	......	82.2	......	94.7	97.2	83.4
Cottonseed meal, medium grade	123	2	61.4	64.1	......	72.6	37.8	67.8	90.1	58.7
Cottonseed meal, low grade	124	2	73.0	78.0	......	83.6	......	43.5	82.1	71.8
Middlings	121	2	79.8	82.5	......	90.6	......	87.5	84.7	76.8
Corn meal and linseed, 1-1	106	2	89.2	91.2	42.6	87.5	80.4	95.1	85.9	......
Corn meal and linseed 1-1	120	2	83.7	86.6	......	85.3	79.3	89.9	78.7	81.3

* Probably too high.

SUMMARY OF DIGESTION COEFFICIENTS WITH STEERS.

Materials.	Number of experiment.	Number of animals.	Dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Ether extract.	Fuel value.
			%	%	%	%	%	%	%	%
Timothy hay (late cut)	95	2	54.9	55.5	41.5	35.3	54.8	59.4	35.7	51.6
Mixed hay, some clover....	111	2	58.3	59.5	37.9	35.3	59.6	63.0	46.8	55.0
Hay, largely timothy.......	127	2	55.7	57.4	25.6	40.7	57.0	60.0	38.3	51.9
Hay, mixed..................	114	2	58.8	60.2	35.4	47.8	54.7	66.1	45.4	56.9
Sanford corn fodder (few ears glazed)	107	2	72.9	74.6	48.7	56.9	79.8	74.4	72.3	70,8
Sanford corn silage (few ears glazed)	108	2	74.9	76.4	47.4	53.7	77.3	78.8	77.0	74.0
Leaming corn silage (immature corn)	109	2	63.1	64.4	31.7	46.7	67.2	65.1	68.3	62.4
Soy-bean and corn silage...	125	1	70.5	72.2	31.3	56.4	61.7	77.54	90.00	67.7
Soy-bean and corn silage fed with hay..............	126	2	70.3	71.1	45.8	57.7	55.1	80.00	88.00	71.7
Spring wheat bran..........	96	2	66.4	70.7	20.4	73.7	25.9	76.8	78.1	63.5
Winter wheat mixed feed..	97	2	70.76	73.0	34.3	76.7	50.3	76.5	......	70.0
Coarse corn meal	100	2	83.6	86.4	......	45.1	......	90.3	......	80.0
Fine corn meal..............	101	2	86.7	88.5	......	50.6	......	91.3	......	90.0
Feed flour	110	2	67.1	70.3	......	79.95	......	73.3	......	73.9
Middlings	129	2	83.4	88.3	......	72.7	......	98.6	......	82.9
Cottonseed meal (in ration hay 8, meal 1)..............	98	2	77.8	87.8	84.3	76.1	55.1	93.1		
Cottonseed meal (in ration hay 8, cottonseed meal 2)	99	2	76.1	80.8	......	81.6	26.3	84.8		
Linseed meal................	112	2	84.1	87.2	36.8	85.7	69.6	91.4	......	88.4
Corn and linseed meal, 1-1.	113	2	91.5	92.5	52.8	86.2	93.0	96.8	81.3	
Corn and linseed meal, 1-1.	128	2	88.9	90.1	......	85.3	77.4	88.2	......	77.7
Gluten feed..................	116	2	87.6	90.6	......	86.6	......	85.4	80.2	86.3

AVERAGE OF THE DIGESTION COEFFICIENTS OBTAINED WITH SHEEP AND STEERS.

	NUMBER OF THE EXPERIMENT.		DRY MATTER.		ORGANIC MATTER.		ASH.		PROTEIN.		FIBER.		NITROGEN-FREE EXTRACT.		ETHER EXTRACT.		FUEL VALUE.	
	Steer.	Sheep.	Steer.	Sheep.	Steer.	Sheep.	Steer.	Sheep.	Steer.	Sheep.	Steer.	Sheep.	Steer.	Sheep.	Steer.	Sheep.	Steer.	Sheep.
			%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Timothy hay (late cut)	95	88	54.9	48.1	55.5	49.1	41.5	30.7	35.3	33.3	54.8	44.8	59.4	55.8	35.7	27.3	51.6	46.0
Spring wheat bran	96	89	66.4	69.5	70.7	72.8	20.4	31.5	73.7	76.3	25.9	66.7	76.8	73.0	78.1	40.5	63.5	64.0
Winter wheat mixed feed	97	90	70.7	72.5	73.0	77.6	34.3	39.5	76.7	78.0	50.3	72.3	76.5	......	......	......	70.0	71.8
Hay 8 parts, cottonseed meal 1 part.	98	91	57.5	54.3	59.2	55.7	71.1	29.3	56.5	59.5	56.6	49.7	61.2	58.1	69.8	56.1	54.7	51.5
Hay 8 parts, cottonseed meal 2 parts	99	92	59.6	58.7	61.0	59.5	35.5	29.1	68.0	68.5	53.1	50.1	62.1	61.1	68.4	62.2	56.6	53.1
Coarse corn meal	100	93	83.6	83.5	86.4	84.6	......	......	45.1	46.0	......	......	90.3	80.3	......	......	80.0	78.3
Fine corn meal	101	94	86.7	89.2	88.5	90.2	......	......	50.6	63.2	......	......	91.3	88.6	......	......	90.0	88.0
Corn fodder (Sanford corn)	107	102	72.9	64.9	74.6	67.0	48.7	18.6	56.9	46.7	79.8	69.9	74.4	68.2	72.3	59.3	70.8	......
Leaming corn silage	109	103	63.1	60.0	64.4	61.9	31.7	33.3	46.7	50.9	67.2	57.8	64.1	65.0	68.3	75.5	62.4	44.6
Mixed hay (timothy, red top, clover)	111	104	58.3	59.4	59.5	60.5	37.9	40.8	35.3	44.6	59.6	57.5	63.0	64.0	46.8	56.5	55.0	56.4
Linseed meal	112	*	84.1	81.2	87.2	84.5	36.8	69.6	85.7	87.2	69.6	......	91.4	85.5	......	91.9	81.3	88.4
Corn meal and linseed, equal parts	113	106	91.5	89.2	92.5	91.2	52.8	42.6	86.2	87.5	93.0	80.4	96.8	95.1	81.3	85.9	......	......
Soy-bean and corn silage	125	118	70.5	71.4	72.2	73.2	31.3	42.7	56.4	62.6	61.7	65.1	77.5	76.8	90.0	90.3	67.7	69.2
Hay largely timothy	127	119	55.7	49.3	57.4	51.2	25.6	6.2	40.7	36.5	57.0	45.9	60.0	57.7	38.3	57.1	52.0	48.5
Hay, linseed and corn meals	128	120	66.6	61.6	68.3	63.9	31.6	23.5	68.4	64.5	50.1	45.5	72.1	69.7	73.1	68.2	61.3	61.8
Linseed and corn meal, equal parts.	128	120	88.9	83.7	90.1	86.6	......	......	85.3	85.7	77.4	79.3	88.2	89.9	......	78.7	77.7	81.3
Gluten feed	116	*	87.6	86.3	90.6	87.3	......	......	86.6	85.6	......	......	85.4	89.2	80.2	84.4	......	......

* Bul. No. 77, U. S. Dpt. Agrlt.

COEFFICENTS OBTAINED WITH STEERS ALONE.

	Number of experiment.	Dry matter.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.
		%	%	%	%	%	%	%
Hay alone, 16 lbs. ration............	114	58.8	60.2	35.4	47.8	54.7	66.1	45.4
Hay 10 lbs., corn meal 6 lbs	115	68.9	70.4	36.5	51.9	65.8	78.4	61.0
Hay 10 lbs., gluten feed 6 lbs........	116	70.9	72.5	38.6	74.0	68.0	74.2	63.7
Corn meal	115	84.3	85.4	......	56.4	......	90.4	76.8
Gluten feed (10 hay to 6 gluten).....	116	87.6	90.6	......	86.6	......	85.4	80.2
Gluten feed (10 hay, 3 gluten).......	117	90.0	93.4	......	86.0	......	89.5	......

DESCRIPTION OF EXPERIMENTS.

Experiment No. 86.—Clover silage. In the Station report for 1900, page 141, are given the results of a digestion experiment on clover silage. The results there given, especially on protein, were so much lower than those obtained from clover hay that it was thought desirable to repeat them. The results here given on page 196 are even lower than the others obtained, showing that the digestibility of clover is materially decreased by ensiling. The clover was chopped and well packed in the silo and came out in as good condition as any leguminous plant usually does.

Experiment No. 87.—Clover hay. The material used in this experiment was the same as was made into silage. It will be observed that the dry matter of this hay is 13 per cent and the protein over 21 per cent more digestible than in the silage.

Experiments No. 88-95.—Timothy hay. The hay used in this experiment was late cut and rather poor quality, as shown by the analyses and digestibility. It was prepared by chopping to about 2-inch lengths several hundred pounds, enough to last through the experiments with grain rations for the season, and thoroughly mixing to make it uniform. The hay was not very palatable and only small rations could be fed without some being left in the feed boxes. The coefficients obtained with the sheep are somewhat lower than those from the steers and are, probably, too low for the hay when fed with grain.

Experiments No. 89-96.—Spring wheat bran. This material was the ordinary coarse bran from spring wheat. The results show quite close agreement between the two different kinds of animals. The sheep however give coefficients averaging a little higher than the steers.

Experiments No. 90-97.—Winter wheat mixed feed. Winter wheat bran containing some middlings and often called mixed feed. This material gave little higher coefficients than the spring bran. The difference between the results of the different animals was about the same as for the spring bran, the sheep giving slightly higher results.

Experiments No. 91-98.—Mixed ration. Hay and cottonseed meal. A ration containing 8 parts hay to 1 of cottonseed meal was fed and the coefficients obtained for the mixture are given. The steers in this gave slightly higher results, except on protein. The cottonseed meal used was of the highest grade, carrying over 46 per cent protein.

Experiments No. 92-99.—Mixed ration. Hay and cottonseed meal. In these experiments the cottonseed meal was doubled and 8 parts hay to 2 parts cottonseed meal were used. The results obtained for the different animals agree very closely. Increasing the grain ration appeared to be favorable to the sheep.

Experiments No. 93-94-100-101 were made to compare the digestibility of coarse corn meal with that of finely ground. Both lots of animals gave higher coefficients for the fine meal than for the coarse, with quite close agreement, except on protein; and the low protein content of the ration probably accounts for that variation.

Experiments No. 102-107.—Corn fodder. The cut corn fodder used in these experiments contained very few ears that were glazed, most of them being immature when harvested. It was well cured and in good condition when fed. The steers ate their rations well, but the sheep did not appear to relish it and left a part of each ration. The coefficients obtained are considerably higher for the steers than the sheep, indicating that palatability may affect digestibility.

Experiment No. 108.—Sanford corn silage. This silage was made from the same material as the corn fodder. The coefficients obtained are slightly higher than those for the fodder cured by drying, except for the protein, which is lower. Only the steers were used in this experiment.

Experiments No. 103-109.—Leaming corn silage. The corn from which this silage was made was not as mature as the Sanford corn. This material was in good condition and well relished by both kinds of animals. The results are a little higher for the steers, except on protein.

Experiment No. 110.—Feed flour. In this experiment feed flour was fed with silage to determine the digestibility of the flour. The results with the sheep were unsatisfactory, so only those of steers are given.

Experiments No. 104-111.—Mixed hay. This hay was a mixture of timothy, red top, and clover. Enough for the purpose was chopped and mixed in the usual manner. The coefficients agree very closely, except in protein which is low in case of the steers.

Experiment No. 112.—Linseed meal. This experiment was made to compare the digestibility of linseed meal. The results obtained for the sheep were unsatisfactory, and those given were taken from Jordan's compilation, Bul. 77, Office Expt. Stations, U. S. Dept. of Agr., which agree well with those obtained for the steers.

Experiments No. 106-113.—Linseed meal and corn meal. This experiment was made with linseed and corn meal, equal parts mixed. The coefficients of both steers and sheep are quite high, but agree very closely. The protein of the mixture is as digestible as that of the linseed alone.

Experiment No. 114.—Hay (mixed). The digestibility of this hay was determined for use in subsequent feeding experiments with grain. The sheep secured proved unsatisfactory, as before stated, and only the steers were used.

Experiment No. 115.—Hay and corn meal. Ten pounds of hay were fed with six pounds of corn meal.

Experiment No. 116.—Hay and gluten feed. Ten pounds of hay were fed with six pounds of gluten feed.

Experiment No. 117.—Gluten feed. Ten pounds of hay were fed with three pounds of gluten feed.

Experiments No. 118-125.—Soy bean—corn silage. This material was grown on the farm and was put in the silo in the proportion of nine parts of beans to fourteen of corn. The coefficients for the different kinds of animals agree very closely. The material was well relished.

Experiment No. 126.—Soy bean—corn silage. In this trial only the steers were used and the silage was fed with some hay. It will be noticed that the results are practically the same for the silage as when it was fed alone.

Experiments No. 119-127.—Hay. This hay was largely timothy of fair quality. The steers in this experiment as in Nos. 88-95 gave higher digestion coefficients than the sheep, although this was a different lot of sheep.

Experiments No. 120-128.—Linseed and corn meal. A mixture of hay, linseed and corn meal was fed. The steers as before gave slightly higher results, but the coefficients agree quite well with the ones obtained in Experiment No. 113, particularly the protein.

Experiments No. 121-129.—Middlings. In these experiments, through a mistake, two different lots of middlings were used, therefore the results cannot be compared.

Experiments No. 122-123-124.—Cottonseed meals. These meals are of different grades and the experiments were made with sheep. These meals will be made a subject for discussion in a later bulletin, consequently the coefficients obtained are presented here without comment.

DISCUSSION OF RESULTS.

In studying the table giving the coefficients obtained from the steers and sheep, it will be noticed that there are differences which are somewhat remarkable and should have some explanation. In experiments No. 88-95 with hay alone, the steers gave a coefficient over 6 per cent higher for the dry matter than the sheep, but in the next two experiments when bran was fed with the hay, the sheep gave higher coefficients for bran than the steers. Also in experiments No. 91-98, when one part cottonseed meal to eight parts hay is fed, the steers show only 3 per cent greater digestibility for the dry matter of the ration; and in the following experiment, where two parts cottonseed meal to eight of hay are fed, the steers digest only 1 per cent more of the dry matter from the mixture. Calculating the digestibility of the cottonseed meal for the sheep, using the coefficients obtained in experiment No. 88 for the hay, gives a coefficient for the dry matter of nearly 100 per cent when one part of cottonseed meal is fed, and when two parts are fed about 94 per cent for the dry matter. This seems to indicate one of two things, that the coefficients for the sheep on the hay are too low, or the addition of the grain to the ration materially increased their capacity to digest the hay. It is quite probable that this latter explanation is the correct one, as other experiments show they have no greater capacity to digest cottonseed meal than the steers. The experiment with the hay was carefully made, the results of the two sheep agree closely and there is no reason to distrust the figures. The hay was rather poor quality, very low in protein and not as well relished by the sheep as the steers. In experiment No. 119 the sheep gave coefficients for dry matter only about 1 per cent higher on a somewhat better timothy hay and were still 6 per cent below the steers.

In the experiment with corn fodder (which the sheep did not relish) the steers gave coefficients nearly 10 per cent higher on the dry matter than the sheep; but in the experiment with corn silage, which was well relished by both lots of animals, the coefficients agree more closely.

In the third season, when the experiments were made only with the steers, there are some results obtained on the digestibility of gluten feed and corn meal which are of special interest. (See table on page 199.) In experiment No. 115 a ration of 10 pounds of hay to 6 pounds of corn meal was fed. And in experiment No. 116 10 pounds of hay to 6 pounds of gluten feed was given. In the mixture with corn meal 68.9 per cent of the dry matter was digested and only 51.9 per cent of the protein, but in the ration where the corn meal was replaced by the gluten feed, 70.9 percent of the dry matter was digested and 74.5 per cent of the protein—a difference of 2 per cent of the dry matter and over 22 per cent for the protein. Calculating the digestibility of the corn meal and gluten alone, the dry matter of the corn meal is 84.3, the gluten 87.6, while the protein of the corn meal is 56.4 per cent and the gluten feed 86.6 per cent—a difference in dry matter of about 3 per cent and protein about 30 per cent. When the protein of these two rations is from the same source, corn, it seems very improbable that such a difference in digestibility exists, and the very low figures obtained for the corn meal are due to metabolic products in the feces, which offset the coefficient much more when a ration very low in protein is fed, than when it is well balanced. It is probable that the protein of the corn meal is really as digestible as that of gluten feed, and this assumption seems to be supported by experiments No. 106-113-120-128 where corn and linseed meals are fed in equal parts, and the coefficients for the protein of the mixed grains are 86.2 and 85.3. This higher coefficient cannot be attributed to the greater digestibility of the linseed, for experiment No. 112 on linseed alone gave a coefficient of only 85.7 for the protein. A more nitrogenous or better balanced ration may in part account for the greater digestibility of the dry matter and protein.

CONCLUSIONS.

Of the animals used in these experiments the steers had a greater capacity for digesting coarse fodders low in protein, like timothy hay and corn fodders, than the sheep.

The more nitrogenous rations were as well and in some cases better digested by the sheep than by the steers, and the addition of nitrogenous grains to the ration appeared to materially increase the sheep's digestive capacity.

The feeding of grain rich in protein with corn meal apparently increased the digestibility of the ration, particularly that of the protein.

It is evident from a study of these results and others before published that as great differences in digestion coefficients will occur between sheep, individually, as is likely to occur between sheep and steers. But if sheep are to be used to determine coefficients for bovines, great care should be taken to select strong animals that are good feeders and will eat coarse fodders readily, otherwise results which are too low are likely to be obtained.

THE INCOME AND OUTGO OF NITROGEN.

J. M. Bartlett.

In conducting digestion experiments in which the urine can be collected, it is customary to make a comparison between the amount of nitrogen taken into the body and that excreted during the same period. This comparison of the income and outgo constitutes what is known as the nitrogen balance. It is made for the purpose of ascertaining if the loss of nitrogen in the urine and feces is made good by the food. Too much is not claimed for the results thus obtained, since it is known that a part, at least, of the nitrogen taken in is delayed in its passage through the body. This nitrogen lag makes it impossible to tell if the nitrogen excreted during any period exactly corresponds with the income at any preceding period. Nevertheless, if the experiment be continued for a considerable length of time, an equilibrium must at length be established. If the body is not gaining weight, the outgo should now exactly counterbalance the income. On the other hand, an excess of income nitrogen indicates a gain, and a deficiency a loss in body weight. In the experiments described in the preceding pages the feces and urine were collected only after a preliminary feeding period of seven days, when it would seem that the equilibrium must have been established.

The whole amount excreted by the sheep for the five days was weighed, thoroughly mixed, and a sample drawn for analysis. Each day's excretion from the steers was weighed and an aliquot portion taken for a composite sample. The samples were preserved with formaldehyde. The following tables give the data obtained on the urines in these experiments.

NITROGEN IN THE URINE—SHEEP.

Number of experiment.	Animal's number.	Weight of urine.	Per cent of nitrogen in urine.	Weight of nitrogen.	HEAT OF COMBUSTION. Per gram.	HEAT OF COMBUSTION. Total.
		Grams.		Grams.	Calories.	Calories.
89	I	3172.0	1.77	56.14	-	-
89	II	2432.0	2.08	50.59	-	-
89	III	2540.0	2.08	52.00	-	-
91	I	1962.0	1.76	34.53	-	-
91	II	1945.0	1.93	37.54	-	-
92	I	3106.0	2.61	81.07	311	966
92	II	3501.0	2.35	82.27	257	900
93	I	2214.0	0.62	15.66	225	497
93	II	2238.0	0.70	15.67	200	448
94	I	1795.0	0.87	15.62	295	529
94	II	1732.0	0.87	15.07	278	481
105	I	2860.0	2.80	80.28	376	1075

NITROGEN IN THE URINE—STEERS.

Number of experiment.	Animal's number.	Weight of urine.	Per cent of nitrogen.	Weight of nitrogen.	HEAT OF COMBUSTION. Per gram.	HEAT OF COMBUSTION. Total.
		Grams.		Grams.	Calories.	Calories.
95	I	16960	0.59	100.1	.281	4770
95	II	17370	0.59	102.5	.281	4881
96	I	15780	0.97	153.1	.204	3220
96	II	17830	0.86	153.3	.213	3797
97	I	11110	1.16	128.9	.303	3367
97	II	16920	0.75	126.9	.179	3029
98	I	15330	1.37	214.6	.266	4078
99	I	13970	1.87	261.3	.407	5975
99	II	16650	1.48	246.4	.374	6326
100	I	20320	0.35	711.3	.192	3946
100	II	16100	0.45	725.0	.214	3446
101	I	15330	0.45	690.0	.183	2806
101	II	15060	0.46	692.7	.190	2861
107	I	11020	1.11	122.3	.249	2743
107	II	12020	1.14	137.0	.256	3077
108	I	25850	0.20	517.2	.086	2223
109	I	22910	0.25	573.0	.111	2543
109	II	30250	0.24	727.7	.107	3237
110	I	15740	1.20	188.9	.278	4476
110	II	24670	0.92	227.0	.192	4736
112	I	15420	1.36	209.2	.246	3793
113	I	13020	1.43	181.6	.320	4166
113	II	12880	1.47	189.4	.332	4277
114	I	21550	0.91	196.1	.242	5215
114	II	21320	0.96	204.7	.264	5630
115	I	21090	0.94	198.3	.255	5380
115	II	18870	1.05	198.1	.299	5640
116	I	24400	2.12	517.3	.352	8588
116	II	23590	2.25	530.8	.355	8376
117	I	20180	1.74	351.1	.296	6270
117	II	21950	1.78	391.0	.277	6078

BALANCE OF INCOME AND OUTGO OF NITROGEN FOR EACH EXPERIMENT—STEERS.

Number of experiment.	Animal's number.	Income nitrogen in food.	Outgo.			Nitrogen, gain+ loss—	Protein, gain+ loss—
			Nitrogen in feces.	Nitrogen in urine.	Nitrogen total.		
		Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
95	I	141.5	95.9	100.1	196.0	—54.5	—340.7
95	II	141.5	89.2	102.5	191.7	—50.1	—313.5
96	I	309.3	129.1	153.1	282.2	+27.1	+169.2
96	II	309.3	128.1	153.3	281.4	+27.9	+174.6
97	I	299.4	119.7	128.9	248.6	+50.8	+320.2
97	II	299.4	122.2	126.9	249.1	+50.3	+314.2
98	I	327.5	143.5	214.6	358.1	—30.6	—189.3
99	I	480.8	153.0	261.3	414.3	+66.5	+415.7
99	II	480.8	155.3	246.4	401.7	+79.1	+494.4
100	I	247.2	153.2	71.1	224.3	+22.9	+142.9
100	II	210.9	148.4	72.5	220.9	—10.0	—62.5
101	I	245.4	150.6	69.0	219.6	+15.8	+98.8
101	II	209.1	123.0	69.3	192.3	+16.8	+105.2
107	I	215.9	91.6	122.3	214.0	+1.9	+12.2
107	II	215.9	93.4	137.0	230.4	+14.5	+90.7
108	I	205.0	94.4	51.7	146.1	+58.9	+368.3
109	I	174.2	91.2	57.3	148.5	+25.7	+160.8
109	II	174.2	94.6	72.6	167.2	+7.0	+43.9
110	I	484.4	137.7	188.9	326.6	+157.8	+986.6
110	II	484.4	127.2	227.0	354.2	+130.2	+813.8
112	I	489.0	175.3	209.7	385.0	+104.0	+649.2
113	I	565.7	171.1	181.6	352.7	+213.0	+1331.0
113	II	565.7	173.5	189.4	362.9	+202.8	+1268.0
114	I	342.0	178.5	196.1	374.6	—32.6	—203.8
114	II	342.0	181.7	204.7	386.4	—44.4	—277.5
115	I	434.1	211.8	198.2	410.0	+24.1	+150.5
115	II	434.1	211.4	198.1	409.5	+24.6	+153.8
116	I	834.2	216.0	517.6	733.6	+100.6	+628.7
116	II	834.2	210.0	530.8	740.8	+93.4	+586.6
117	I	567.5	184.5	351.1	535.6	+33.9	+227.4
117	II	567.5	183.1	391.0	574.1	—6.6	—41.4

BALANCE OF INCOME AND OUTGO OF NITROGEN FOR EACH EXPERIMENT, SHEEP.

Number of experiment.	Animal's number.	Income nitrogen in food.	Outgo.			Nitrogen, gain+ loss—	Protein, gain+ loss—
			Nitrogen in feces.	Nitrogen in urine.	Nitrogen total.		
		Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
89	I	63.3	25.20	56.14	81.34	—18.04	—112.7
89	II	63.3	26.14	50.59	76.73	—13.43	—83.96
89	III	63.3	24.38	52.00	76.38	—13.08	—81.78
91	I	68.6	32.16	34.53	66.69	+1.91	+11.97
91	II	68.6	27.80	37.54	65.34	+3.26	+20.32
92	I	106.0	30.76	81.07	111.83	—5.83	—36.43
92	II	106.0	33.10	82.27	115.37	—9.87	—58.58
93	I	38.5	23.74	13.66	37.40	+1.10	+6.88
93	II	38.5	23.22	15.67	38.89	—0.39	—2.44
94	I	38.0	19.94	15.62	35.56	+2.44	+15.25
94	II	38.0	21.19	15.07	36.26	+1.74	+10.88
105	I	127.7	26.14	80.28	106.42	+21.28	+13.30